

Perimortem caesarean section – why, when and how

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The Obstetrician & Gynaecologist.

[Manuscript title:] Perimortem caesarean section – why, when and how

[Running title:] Perimortem caesarean section

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Disclosure of interests

KH, SP-B and PS are members of the MOET UK Working Group. KH is Chair of the UKOSS Steering Committee. [JJC, TJ, MM and JW have no competing interests to disclose.](#)

Contributions to authorship

JJC researched, wrote and edited the article. KH researched and edited the article; SPB, TJ, MM, JW and PS edited and approved the final version.

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Comment [JC(GaD1): The disclosure of interests are correct but I have added that the other authors have no competing interests to disclose

[Abstract]

Key content

- Cardiac arrest in pregnancy is rare. Effective management involves the decision to perform a perimortem caesarean section if the gestation is greater than 20 weeks and return of spontaneous circulation does not occur after 4 minutes of effective cardiopulmonary resuscitation.
- Delivery should ideally be achieved within 5 minutes of cardiac arrest as this maximises maternal survival and reduces the risk of long-term neurological impairment.
- In hospital, the procedure should be undertaken at the site of the cardiac arrest without moving to an operating theatre.
- Minimal equipment is required to undertake the procedure. Clinical areas where pregnant women are seen should have a designated 'equipment box'.
- Debriefing all personnel is of utmost importance after the acute event.

Learning objectives

- To understand why perimortem caesarean section is beneficial to maternal survival.
- To appreciate the need for rapid decision making when perimortem caesarean section is required.
- To gain practical knowledge of perimortem caesarean section, including the steps to be used when resuscitation is unsuccessful.

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Ethical issues

- To be aware that the primary aim of perimortem caesarean section is to aid maternal survival, not necessarily fetal survival.

Keywords: cardiac arrest / maternal cardiac arrest / perimortem caesarean section / resuscitative hysterotomy

[Heading 1] Introduction

Maternal cardiac arrest is a rare event occurring in approximately 1 in 12 500 pregnancies.^{1–4} The most common causes of cardiac arrest in pregnancy are haemorrhage (45%), amniotic fluid embolism (13%), heart failure (13%), anaesthetic complications (8%) and trauma (3%) (see Figure 1).^{1,5,6,7} Because it is so rare, most obstetricians are unlikely to encounter this challenging situation more than once during their career.⁸ When a maternal cardiac arrest does occur, the prospect of performing a perimortem caesarean section (PMCS) is daunting for any healthcare professional, even the most experienced obstetricians. Failure to institute effective life support, which includes performing PMCS in good time, carries devastating consequences for families.⁹ Even when abdominal delivery is expedited in a timely manner, maternal survival remains low (17–59%),^{1,3,4} although fetal survival may be higher (61–80%).^{1,10,11} The key to achieving optimum maternal and fetal survival is the rapidity with which the PMCS can be performed following onset of cardiac arrest.¹²

This article explores the rationale for performing PMCS and reviews maternal and fetal outcomes.

The authors describe recently proposed alternative terminology and offer practical, step-by-step

Comment [LM1]: AU/ED: Please note the comments I have made on the PPT file re: this figure.

Comment [LW2]: AU: GTG ref moved from no. 13 to no. 7, as it will appear earlier in the text when the ref. is added to the figure 1 legend. References 7-13 renumbered, please check these are OK.

Comment [JC(GaD3)]: The numbering is fine

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advice for performing the procedure. Finally, they will consider how care can be improved with better use of simulation and in-house training.

[Heading 1] Perimortem caesarean section – why and when?

In maternal cardiac arrest, the resuscitation algorithm followed is essentially the same as that for nonpregnant women, apart from certain specific anatomical considerations (e.g., manual displacement of the gravid uterus and placement of defibrillator pads).¹³ However, the main difference in the continuing management of cardiac arrest in pregnancy is the critical decision to perform PMCS if cardiopulmonary resuscitation (CPR) fails to result in rapid return of spontaneous circulation (ROSC). The current Royal College of Obstetricians and Gynaecologists' (RCOG) guideline *Maternal Collapse in Pregnancy and Puerperium*⁷ recommends that PMCS should be performed if there is no ROSC after 4 minutes of correctly performed CPR in a woman who is greater than 20 weeks of gestation. Delivery of the fetus should ideally be completed 5 minutes after cardiac arrest. The guideline is clear that the procedure is primarily used to assist maternal resuscitation rather than to save the fetus. This has led to the recent recommendation from trauma colleagues to use the alternative term 'resuscitative hysterotomy' (RH).^{14,15} The term PMCS is more familiar in obstetric circles and the authors feel that both terms are acceptable to use in clinical practice.

The time targets of 4 and 5 minutes are sourced from a seminal article published by Katz et al. in 1986.¹⁰ The case series focused on infant survival, with 42/61 (69%) surviving when PMCS was undertaken within 5 minutes of cardiac arrest. In reviewing a smaller case series, Katz also noted that maternal hypoxic brain injury only occurred in those women who underwent a caesarean delivery that was started 6 minutes or more after cardiac arrest.² Although research evidence for this is not robust, the physiological plausibility is clear: pregnant women are likely to become hypoxic more rapidly than nonpregnant women because of higher oxygen demand.¹⁶ Additionally,

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the gravid uterus impairs venous return with aortocaval compression, reducing cardiac output by up to 60%. Emptying the uterus by delivering the fetus reduces compressive forces on the great vessels (thereby increasing cardiac preload) and reduces oxygen consumption. Lastly, emptying the uterus allows more effective maternal CPR⁷ and potentially more rapid ROSC.

The rarity of maternal cardiac arrest and the relatively uncontrolled nature of the clinical situation mean that research evidence is understandably scarce.¹¹ Evidence supporting the practice of PMCS is limited to case reports and case series.

Following on from the original recommended targets of 4 and 5 minutes, in 2005 Katz et al. published a literature review of 38 cases of PMCS to confirm the benefits of swift delivery in maternal cardiac arrest.¹² Twenty cases of cardiac arrest were associated with causes where resuscitation was potentially possible. In these cases, 13 (65%) mothers were successfully resuscitated and discharged. Moreover, in 12 out of 18 cases where the haemodynamic status was reported before and after PMCS, delivery of the fetus preceded return of spontaneous circulation. Importantly, this review found that the mothers' condition did not deteriorate because of the procedure. Katz et al. concluded that the data generated from their review supported but fell short of proving the true validity of the 4 and 5-minute rules.

[Heading 1] Maternal and fetal outcomes

Several other reviews have collated the outcomes for mothers and neonates following PMCS. The most recent¹⁷ was a systematic review with strict inclusion criteria for selecting primary articles published between 1980 and 2010. The search yielded a total of 80 relevant papers, including a total of 94 patients. The primary outcome measures were maternal and neonatal survival to discharge from hospital; secondary outcome measures were neurological disability and feasibility to undertake PMCS within the advocated timeframe.

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Einav et al.¹⁷ found that PMCS was beneficial in 31.7% of cases and 'not harmful' in any of the identified cases. The review identified that 54.3% (51/94) of mothers survived to hospital discharge, with 78.4% (40/51) surviving with good to moderately impaired neurological outcome. The review also established that if the PMCS was performed within 10 minutes of cardiac arrest, maternal outcomes were more favourable (odds ratio [OR] 7.42, $P < 0.05$). Furthermore, neonatal survivors had a shorter mean cardiac arrest-to-delivery time of 14 ± 11 minutes compared to non-survivors (22 ± 13 minutes). Neonatal survival only occurred in cases of maternal cardiac arrest in hospital. The reality is that PMCS is not usually started, nor is the fetus delivered, within the ideal 4 and 5-minute timeframes. Even when these timeframes are breached, maternal or fetal benefits are still possible, with reports of healthy infants being delivered 30 minutes after maternal cardiac arrest.¹⁷ The time can be foreshortened in the labour ward by undertaking the procedure in the delivery room. There is no advantage in transferring the woman to an obstetric theatre because this adds unnecessary delay. For out-of-hospital arrest, it is more difficult to offer definitive advice. Although there are trauma-trained doctors who can potentially perform PMCS outside of hospital, the decision to do so is specific and individualised. In most cases, we expect the woman to be transported to the nearest accident and emergency or trauma department. To minimise further delay on arrival, the most senior obstetrician available should attend and be present in the department when the woman arrives.

[Heading 1] Initial resuscitation and perimortem caesarean section

In maternal cardiac arrest, the resuscitation process follows similar algorithms to the nonpregnant woman.¹³ Look for signs of life on arrival (check for breathing and carotid pulse). In the hospital situation, if these are not detected, a call for the cardiac arrest team should be made at the earliest opportunity. At the same time, an emergency call for the obstetric, obstetric anaesthetic and

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neonatal resuscitation teams should be made; specifically, the consultant obstetrician and consultant anaesthetist should be included.

Standard basic life support (BLS) should be initiated, using CPR with 30 cardiac compressions to 2 ventilation breaths. Important considerations during initial resuscitation are detailed below.

[Heading 2] Airway

Standard airway manoeuvres should be performed while looking for signs of life (i.e., head tilt and chin lift, or jaw thrust).¹³ Advanced airway management is usually required and should be anticipated. Difficulties can be encountered, especially in the third trimester. The risk of gastric aspiration is high because of the pressure of the gravid uterus on the stomach and the relative laxity of the cardiac gastric sphincter (a progesterone effect). An experienced anaesthetist should establish an early definitive airway because of the high risk of aspiration during intubation and intubation failure.¹² This usually involves intubation with a cuffed endotracheal tube, taking care not to damage oedematous respiratory tissue. The use of a smaller diameter endotracheal tube should be considered to reduce the risk of failed intubation.¹³

[Heading 2] Breathing

Physiological changes occurring in pregnancy lead to higher oxygen consumption and demand.¹⁸ Deoxygenation occurs more rapidly in maternal cardiac arrest so supplemental oxygen should be given with a gas flow of 10–15 l min⁻¹.¹⁹ There are some recent concerns suggesting that high flow oxygen supplementation might be detrimental to the fetus in utero and could increase the requirement for neonatal resuscitation.^{20–23} However, in maternal cardiac arrest, the priority is to maximise the chances of maternal survival, thus high flow supplemental oxygen should be administered.²¹ The aim is to achieve arterial oxygen saturation (SaO₂) of 94–98%.

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141

142 [Heading 2] Circulation

143 Cardiac compressions have a direct effect on outcome so should be performed immediately and
144 competently.¹³ However, it is also vital to ensure that the compressive effect of the uterus on the
145 vena cava is alleviated from the start (see manual uterine displacement below).

146 Thirty cardiac compressions (at a rate of 100 per minute) should be performed to every
147 two ventilation breaths until defibrillator pads and the defibrillator are available. Once the patient is
148 intubated, ventilate at a rate of 10 breaths per minute with continuous chest compressions at
149 100 per minute without pausing during ventilation. If the maternal breasts are large or engorged,
150 defibrillator pads may need to be placed on the anterior and posterior precordium to optimise
151 defibrillation energy transfer.

152 Manual uterine displacement is preferred to reduce compression of the inferior vena cava by the
153 gravid uterus (see Figure 2). The uterus should be manually displaced using an 'up, off and over'
154 technique. Maintaining the woman in a fully supine position with the uterus manually displaced
155 makes cardiac compressions easier and more likely to be effective. Alternatively, a left lateral tilt to
156 an angle of at least 15° can be used:^{24,25} slide a solid wedge extending from shoulder to pelvis under
157 the woman to ensure effectiveness.

158 Early vascular access should also be obtained, ideally with two wide-bore (minimum 16 G) cannulae
159 above the level of the diaphragm so that fluids administered are not affected by aortocaval
160 compression.^{7,13} Intraosseous access should be considered in situations where rapid access is
161 required or where intravenous cannulation is difficult. In a maternal cardiac arrest, aggressive fluid
162 resuscitation should be initiated as soon as is practicable. Blood should be requested early and
163 administered according to clinical need.

164

Comment [LM4]: AU/ED: Please note the comments I have made on the PPT file re: this figure.

Comment [JC(GaD5)]: Hi Lisa, We now have permission to use the manual displacement figure from MOET. I have sent the email thread documenting the permission granted. Justin

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[Heading 1] The decision to proceed with perimortem

caesarean section

If there is no ROSC after 4 minutes of effectively performed CPR, a clear decision should be made rapidly to start PMCS. The gestational age should be 20 weeks or greater. When gestation is uncertain or where notes or history are not available, the decision to proceed should be made based on a careful, clinical estimation of gestation. A useful working rule is to undertake PMCS/RH if the uterine fundus is at or above the level of the umbilicus. The practical steps to be followed are detailed below. To optimise maternal outcome, note that cardiopulmonary resuscitation should continue uninterrupted during the procedure until either ROSC is confirmed, or until the formal decision to stop resuscitation is made at senior level.

[Heading 1] Where should perimortem caesarean section

be performed?

In the hospital setting, the PMCS can become delayed if the woman is moved to the operating theatre,^{8,17} so the surgery should be performed in the delivery room or in the emergency department. In rare circumstances, PMCS may be considered in the pre-hospital care setting but only when appropriately trained members of medical staff are available.²⁶ It is difficult to give more specific guidance since the decision to undertake PMCS out of hospital or to rapidly transport the patient to hospital is always made on a case-by-case basis. PMCS following cardiorespiratory arrest requires no general anaesthesia and bleeding is initially minimal. However, with successful ROSC, general anaesthesia must be available to allow surgery to be completed.

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186

187 [Heading 1] Perimortem caesarean section: practical steps

188 [Heading 2] Preparation

189 Full surgical scrub is not required and only basic personal protective equipment should be worn
190 (disposable gloves and apron). Wearing full gowns/masks can cause delays and ‘full sterility’ is not
191 required. The abdomen should be cleansed where possible, but this should not delay starting the
192 procedure. Minimal equipment is required to perform PMCS: a scalpel and two ligatures or clamps
193 for the umbilical cord. This equipment should be available in hospital departments where obstetric
194 patients are commonly seen because PMCS is usually performed at the site of the cardiac arrest.
195 Although resuscitation guidelines suggest that only a scalpel is required on a cardiac arrest trolley, it
196 is useful for obstetric teams to liaise with relevant departments (e.g., accident and emergency and
197 outpatient departments) to develop a ‘PMCS box’ similar to the ‘eclampsia box’ used on many
198 labour wards (see Box 1). This makes additional equipment available with minimal delay. The
199 bladder does not need to be routinely emptied and general anaesthesia is not required to start
200 the procedure.

201

Comment [LM6]: ED/AU: I have changed Table 1 to a Box because it contains only a single-column list.

Comment [JC(GaD7)]: We are happy to have this as a box rather than a table

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Box 1. Recommended content for a 'perimortem caesarean section (PMCS) emergency box'

Contents is simple and should include:

- Sterile gloves (where not immediately available)
- Disposable apron (where not immediately available)
- Solution for skin preparation/gauze to apply
- Curved no. 10 scalpel blade pre-mounted on disposable handle (or fixed blade scalpel)
- Three disposable cord clamps (or ligatures for hand-tying)
- Sterile intra-abdominal gauze pack/swab (for applying pressure if needed)

Consider:

- Two towels for drying and wrapping baby

202

203 [Heading 2] Abdominal entry

204 For PMCS it is best to make a lower abdominal, vertical midline incision (starting at or just below the
205 umbilicus) because this provides the quickest route of entry into the abdomen to deliver the fetus

206 and offers maximal [access to the abdominal cavity](#) exposure.⁶ Some obstetricians and gynaecologists

207 are less familiar with this route of abdominal entry, so a vertical or transverse incision can be used;

208 whichever the clinician feels will provide the most rapid access in their hands.^{7,8} However, if intra-

209 abdominal trauma is a possibility (e.g., in penetrating injury, or suspected hepatic, splenic, bowel or

210 major vessel injury), then a vertical subumbilical, midline incision should always be used. The incision

211 passes sequentially through skin, subcutaneous fat and the fibrous linea alba (in the midline

212 between the rectus abdominis muscles), before finally dividing the parietal peritoneum and entering

Comment [LM8]: AU: Maximal exposure to what? Please clarify

Comment [JC(GaD9)]: Text changed for clarification

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the abdominal cavity. During entry, care should be taken to avoid damaging other organs, though bladder injury is accepted as a particular risk. If this occurs, it can be identified, assessed and repaired at a later stage, assuming successful resuscitation.

[Heading 2] Uterine incision

The choice between a lower segment transverse incision and a vertical (classical) incision in the uterus depends on several factors, including the operator's experience and, importantly, the gestation. The type of uterine incision chosen should facilitate the quickest possible delivery of the fetus. If the surgeon is inexperienced in performing caesarean sections, or if the lower segment is narrow (more likely at 20–28 weeks of gestation), then a vertical midline incision should be made in the anterior uterus. This can begin near to the fundus and extend down towards the lower segment. Try to avoid injury to the fundus of the bladder, which can reach the upper margin of the lower segment. The uterine upper segment is relatively thick (3–4 cm) and superficial injury to the fetus is a risk during rapid entry. Use scissors or a scalpel to enlarge the vertical uterine incision in both caudal and cephalic directions. Once most of the muscle fibres have been cut, it can be helpful to stretch the uterine incision with the fingers to provide a wide, open access point that allows easy delivery.

If the lower segment is reasonably well formed (which it might not be until at least 28 weeks of gestation) or the surgeon is familiar with caesarean sections, then a transverse lower segment incision may be considered. However, this can cause some delay because the bladder must be mobilised from the lower segment. The cord should be double-clamped or ligated and promptly divided between the clamps/ligatures (use a skin scalpel if scissors are not available). Be aware that if the baby is alive, active neonatal resuscitation is required.

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236

237 **[Heading 2] Managing the placenta**

238 Once the baby is delivered, the placenta can be delivered or left in situ, but maternal resuscitation
239 should continue. Management is dictated by the subsequent effectiveness of continuing
240 resuscitation. If resuscitation is successful, increasing uterine tone will cause placental separation
241 and the placenta can be delivered. Be prepared for bleeding and ensure that uterine tone is
242 appropriate and maintained.

243

244 **[Heading 2] Management when resuscitation is successful**

245 With ROSC, bleeding can arise from an atonic uterus (requiring appropriate uterotonic medication)
246 and/or from the edges of uterine incision. The latter can be initially managed by applying local
247 pressure, using a handheld sterile pack or large gauze swabs if available. General anaesthesia should
248 be administered and the woman transferred as soon as possible to an operating theatre for formal
249 exploration and closure. Appropriate broad-spectrum intravenous antibiotics should be given and
250 duration of treatment clearly documented.

251 The uterus and abdomen should be anatomically closed to achieve adequate haemostasis. Lower
252 segment incisions can be closed in a standard way, but upper segment incisions usually require
253 three layers of sutures to ensure closure and to secure haemostasis. Number 1-sized suture material
254 should be used (braided polyglactin or similar) to reduce the risk of tearing through the uterine
255 muscle. It is vital to have an assistant on hand during closure so they can hold the thick walls of the
256 upper uterine segment together while individual sutures are inserted and tied. The first layer should
257 be closed using interrupted figure-of-eight or 'Z' stitches because these are more haemostatic.
258 Depending on factors including the amount of bleeding and tissue friability, subsequent layers might
259 also require interrupted sutures. Adequate time should be allowed for uterine closure to ensure that
260 uterine perfusion and blood pressure have normalised to ascertain haemostasis. However, if

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bleeding continues, abdominal and/or pelvic packing might be required.^{13,27} A large-bore, non-suction tube drain should be left in place. If a pack is left in situ, the abdomen should be partially closed with only a few skin sutures – a return to theatre is expected within 24 hours to remove the pack and undertake definitive closure. After surgery, immediate and continuing care usually takes place on an intensive critical care unit. The final destination depends on the cause of cardiac arrest and the woman's overall clinical state. In all circumstances, senior medical staff should be involved in a multidisciplinary team discussion to ensure an appropriate decision is made.^{1,7,28,29}

[Heading 2] Management when resuscitation is unsuccessful

After the uterus is emptied, resuscitation efforts should continue until the clinical situation dictates a decision to stop. This decision should be made by the attending senior consultant team (made up of obstetricians, anaesthetists, accident and emergency staff, etc.), together with the cardiac arrest team,⁷ and be clearly stated to ensure that all team members agree. The coroner (or relevant legal entity) should be informed of the death at the earliest opportunity. If a coroner's postmortem examination is required to delineate the underlying cause (or causes) of death, medical devices such as vascular catheters and endotracheal tubes should be left in situ.² Although in England there is no formal national guidance about management of the equipment used or in place at the time of death, the recommendations below should be adhered to;³⁰ these facilitate any postmortem required by the coroner, while remaining sensitive to the family:

1. All intravenous access ports, lines and intubation equipment in place at the time of declaration of death should be secured and left in situ.
2. The placenta should not be removed if it was in place at the time of death, and if the uterus was open it should be left unsutured. Preferably, an open abdomen should be left as such and covered with a dressing. However, out of consideration for the feelings of family

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members, it might be appropriate to close the skin edges of a large incision with a minimal number of simple sutures before covering the wound with a dressing.

3. The state of the abdomen at the time of death should be carefully recorded in the medical records (e.g., whether the abdomen was open, the placenta was in place, the uterus was open or repaired), in addition to whether sutures used to close the abdomen were placed after death.

[Heading 1] After care

After PMCS, appropriate neonatal care and family support is vital, whatever the outcome. Keeping contemporaneous medical notes can be difficult, but all staff should ensure that comprehensive notes are added to the medical/nursing records as soon as possible after the event.^{31,32} Entries should be signed, timed and dated appropriately. As well as accurate documentation, a completed critical incident report is required and, in the event of a maternal death, the coroner must be informed. The importance of confidential enquiries should not be overlooked and appropriate information should be forwarded to the relevant bodies.^{5,6}

The distress caused by a maternal cardiac arrest must not be underestimated. For the family, unsuccessful resuscitation means the loss of a wife, daughter or mother, and possibly a much-wanted baby too. Even if resuscitation is successful, for both the family and the members of staff involved in the patient's care, the emotional trauma from such a dramatic event can have significant emotional consequences.^{15,19,33,34} Primary care and supporting community services should be directly informed as soon as possible after the event, whatever the outcome.

Both relatives and staff members should be offered a thorough debrief with detailed exploration and discussion of the events. These are often held separately for staff and relatives, but later a joint meeting may be requested. The debrief can involve members of the multidisciplinary team including

Comment [LM10]: AU: I have deleted this sentence as it says almost the same thing as the next two sentences.

Comment [JC(GaD11)]: That's fine with us

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paramedics and staff from accident and emergency, theatre, critical care and maternity departments. This must be undertaken at an appropriate time, in a suitable place.^{15,19} It is useful to keep family members abreast of the events as they evolve, particularly in the weeks leading up to their planned formal review or full debrief. Additional pastoral support and counselling should be provided to relatives, staff and other patients who have witnessed the events.

[Heading 1] Improving care

The medical literature to help direct high-quality care in the management of maternal cardiac arrest and PMCS remains sparse.³⁵ Practice will improve as further knowledge is accumulated from case reports, small series and reviews, and the use of confidential enquiries such as MBRRACE-UK (Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK).^{5,6,36,37} Clinicians should continue to report these rare events and, in the UK, the UKOSS reporting system is exemplary.³⁸

Simulation courses such as the PRactical Obstetric Multi-Professional Training (PROMPT)³⁹ course and Managing Obstetric Emergencies and Trauma (MOET)¹³ can help maternity teams to improve technical, communication, decision-making and team-working skills. Simulation training improves clinicians' knowledge and confidence^{3,9} and can facilitate rapid and effective action in maternal cardiac arrest. For example, implementing simulation-based training in the management of a maternal cardiac arrest led to quicker initiation of cardiopulmonary resuscitation and PMCS.⁹ Additionally, competent team performance in the management of obstetric emergencies (such as the management of maternal cardiac arrest) is not a function of the knowledge and skills of individuals but is instead associated with the skills of the team as a whole, including team behaviours and leadership skills. Simulation training develops these team-orientated skills, including allocating tasks to specific team members who know and understand their individual roles.^{40,41} In the authors'

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opinion, multidisciplinary team training in cardiorespiratory arrest leading to PMCS should be a mandatory 'hot drill' that is practiced regularly on all delivery suites.

[Heading 1] Conclusion

Obstetricians will rarely need to perform a PMCS; colleagues in accident and emergency will encounter this clinical situation even more rarely but may be called upon to perform a PMCS in a critical trauma scenario. indeed, some will never come across one, especially our colleagues in accident and emergency or trauma situations, who might be called upon to make the critical, acute decision to proceed. For any individual in this rare situation, the take-home message is to focus on the need for rapid action to maximise the chance of maternal survival. Therefore, the critical step is to make the decision to proceed with a PMCS. Fetal survival depends on many factors including gestation, but is a secondary issue and should not be the prime driver for deciding whether or not to perform a PMCS.

Realistically, the only situation in which PMCS is likely to be achieved within the recommended time frame of 4–5 minutes is when maternal cardiac arrest occurs in the delivery suite. When the woman is in transit by ambulance, the most senior obstetrician available should be urgently called to be present when the woman arrives at the accident and emergency department to minimise delay in proceeding to PMCS. Maternal survival rate falls rapidly with increasing time from the initial arrest. However, if resuscitation attempts continue, we recommend that PMCS should still be performed even when the delay is 30 minutes or more. In hospital situations, PMCS should be performed at the site of cardiac arrest.

Rapid and effective action can be improved through multidisciplinary team training. It is useful for units to consider joint training drills with colleagues in accident and emergency departments. Obstetricians should help to develop joint guidelines that cross departmental boundaries and ensure that, for this rare event, all staff know who to call and when. A 'PMCS box' containing the basic

Comment [LW12]: AU: this appears to say that those working in A&E are especially unlikely to encounter PMCS – just to clarify, is this correct?

Comment [JC(GaD13): I have changed the text to improve clarity

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equipment needed is a useful adjunct. The PMCS procedure is relatively simple and the steps required have been described.

As with all critical obstetric emergencies, detailed documentation is vital. All steps of the acute intervention should be specifically timed and recorded, and health records completed as soon as possible after the intervention. A member of the acute team can be allocated to keep contemporaneous notes and timings throughout the resuscitation period.

High-quality support and care should continue after the acute event, ensuring prompt communication with primary care colleagues and community-based services. A comprehensive and sensitive debriefing should be undertaken, with formal counselling and support to follow when required. Units may wish to consider a joint debriefing/review, which can include both the staff involved in the patient's care and the patient and/or their family members.

[Heading 1] References

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Comment [LM14]: AU: I have replaced the URL here with the direct link to the report rather than the homepage. Please check this is the correct document.

Comment [JC(GaD15)]: This is the correct document

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Comment [LM16]: ED/AU: I have added this personal communication to the list of references as per the journal’s preferred style and renumbered the following references accordingly.

Comment [JC(GaD17)]: That’s fine with me

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Comment [LM18]: AU: I have updated this reference – the original URL pointed to an information page about UKOSS, yet the reference seemed to be citing the annual report. Please check this is correct and amend as necessary.

Comment [JC(GaD19): This new URL is good

468 **Figure legends:**

Perimortem caesarean section

469 **Figure 1.** Causes of maternal collapse. Reproduced with the permission of the Royal College of

470 Obstetricians and Gynaecologists.¹³

471 **Figure 2.** Manual displacement of the uterus.

Figure 1. Causes of maternal collapse.

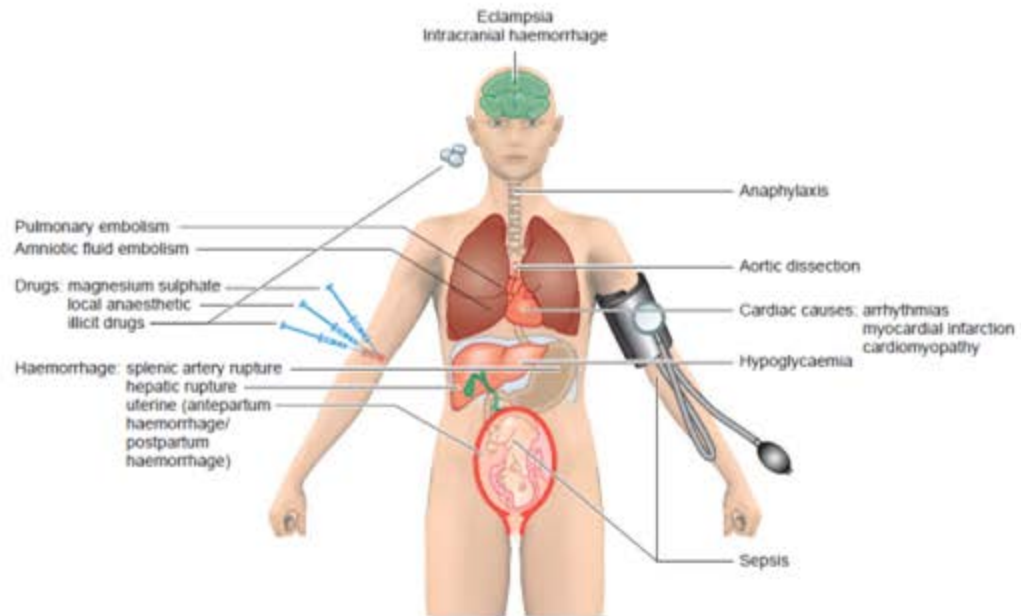


Figure 2. Manual displacement of the uterus.



Box 1. Recommended content for a 'PMCS emergency box'

Recommended content for a 'PMCS' emergency box
<p>Content is simple & should include:</p> <ul style="list-style-type: none">• Sterile gloves (where not immediately available)• Disposable apron (where not immediately available)• Solution for skin preparation / gauze to apply• Curved No. 10 scalpel blade pre-mounted on disposable handle (or fixed blade scalpel)• x3 disposable cord clamps (or ligatures for hand-tying)• Sterile intra-abdominal gauze pack/swab (for applying pressure if needed)
<p>Consider:</p> <ul style="list-style-type: none">• x2 towels for drying & wrapping baby